An Examination of the Hunting-Dependent Life of the Mbuti Pygmies, Eastern Zaire

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African Study Monographs, 4: 55–76, December 1983

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ABSTRACT The possibility of a hunting-dependent life by the Mbuti Pygmies in the Ituri Forest is examined, and ecological and sociological conditions of such a life are discussed. It is concluded that, without the symbiotic partners providing the Mbuti with farm foods, a hunting-dependent life in the Ituri Forest would be quite hard and require much more effort in the subsistence activities than that made by the present-day Mbuti, although it would not be impossible from calorific viewpoint. Stable meat supply, which is pointed out here to be indispensable to a hunting-dependent life, is facilitated by such ecological and sociological conditions as abundant small to medium-sized game animals, their random distribution in the forest, strong correlation between effort and return in hunting, and frequent meat sharing among the band members based on the principle of generalized reciprocity.

INTRODUCTION

The Mbuti Pygmies are hunter-gatherers living in the Ituri Forest, a tropical rain forest in northeastern Zaïre. They are the aboriginal inhabitants of the forest and have subsisted by foraging natural resources for thousands of years. Since the Bantu and the Sudanic agriculturalists immigrated into the Ituri Forest several hundred years ago, the Mbuti have changed their mode of subsistence. They have established a symbiotic relationship in which the Mbuti provide the agriculturalists with meat from the forest and manpower for agricultural works in exchange for metal works and farm foods. Through this interdependent relationship maintained for centuries, hunting has become more important than gathering in the Mbuti's life. They have changed from self-sustaining, generalized hunter-gatherers to specialized hunters, as far as their subsistence activities are concerned. Their diet has also changed. Today, they depend for more than 60% of total food weight on farm products, such as cassavas and plantains, which are now necessities of life.

It is generally accepted that almost all present-day hunter gatherers in Africa, or in the lower latitudes in general, depend more on vegetable food than meat from hunting (Lee, 1968). This view was extended to human evolution studies by Clarke (1976). Tanner (1981) and other researchers who speculated that prehistoric hunter-gatherers in the lower latitudes were more likely to have subsisted by gathering than by hunting. Foley (1982), however, in a reconsideration of the importance of hunting to African hunter-gatherers, stressed that present-day African hunter-gatherers inhabit the areas where biomass of game animals is quite small. According to him, in areas with more abundant large herbivores and less vegetable food, for example in savanna areas, humans must have depended more on hunting than gathering. This is clearly opposed to the generalization proposed by Lee and Tanner. As most researchers hold the view that human evolution took place in open land where herbivores were plentiful, the importance of hunting to human evolution should be reexamined. Whether prehistoric hunter-gatherers depended more on vegetable food or meat is still open to question. Although it is necessary to examine the hunting life in savanna areas in order to answer this question, there is not yet adequate data on hunting in such areas.

In this context, it should be noted that as far as subsistence activities are concerned, the Mbuti subsist mainly by hunting. Gathering vegetable food is of little importance in their present-day life. They provide us with one of the few examples of a hunting-dependent life in the past. The following questions thus become important. Without their symbiotic partners providing them with farm foods, could they subsist by hunting and consuming all the catches by themselves? If they could, what kind of ecological and sociological conditions would be necessary to lead such a hunting-dependent life? This is a pure conjecture and different from the actual life of the present-day Mbuti; nor is it directly applicable to the question of the importance of hunting in savanna areas. Nevertheless it is useful in the effort to reconstruct the prehistoric human subsistence pattern and examine the necessary conditions of a hunting-dependent life.

The Mbuti Pygmies are divided into archers and net hunters according to the principal hunting method employed (Turnbull, 1965). The net hunters live in the southern and southwestern parts of the forest in a symbiotic relationship with the Bira and Ndaka agriculturalists, while the archers in the north and northeastern parts keep contact with the Sudanic (the Lese) agriculturalists. Several studies have been made on net hunters (Harako, 1976; Tanno, 1976; Hart, 1978; Ichikawa, 1982) and archers (Terashima, 1983). These studies have pointed out that net hunting is quite effective and adaptive in the tropical forest environment, yielding fairly reliable catches. This is in contrast to the view presented by Lee (1968) and Tanaka (1980) that hunting among the Bushmen (the San) is far from a reliable method to procure daily food. Reliability and stability of the catch, as well as hunting efficiency, are crucial to maintaining a hunting-dependent life. However, the stability of the net hunting of the Mbuti Pygmies has not yet been analysed in detail. In this study, the stability of the net hunting is analysed from the following four aspects: 1) hunting activity pattern, 2) the catch and efficiency of the hunt, 3) daily fluctuations of the catch, and 4) differences and fluctuations in the catch of individual hunters.

STUDY AREA AND METHOD

Field research was carried out in the Tetri region (Fig. 1), about 50 km south of Mambasa, Central Ituri, from August 1974 to July, 1975, and from October, 1980 to January, 1981. In the Tetri region, there are nine Mbuti bands consisting of 592 people, and about ten villages of the agricultural Bira and the Nande. The area which the Mbuti in Tetri utilize for their subsistence is about 1,200 km^2. The population density of the Mbuti is thus calculated at 0.5 person/km^2, which is equal to the average population density of the Mbuti in the entire Ituri Forest (40,000 Mbutis in 80,000 km^2, according to Ichikawa, 1978), or that in the southern part of the forest calculated from the data in Hart, 1978 (420 persons in 800 km^2). This suggests fairly uniform distribution of the resources in the Ituri Forest, which is also reflected in the almost uniform distribution of the hunting camps in the Tetri region (Ichikawa, 1978). Although accurate climatic data are not available, the mean annual rainfall in eastern part of the forest is about 1,800 mm (Meesen, 1951). There is a short dry season from the end of December to the beginning of March when net hunting is most intensively performed. Other general information about the area and the people were given in the previous paper (Ichikawa, 1978).

A notable change in the Mbuti life which recently occurred is the introduction of meat trading. First introduced to the region by the Nande in the late 1950's (Hart, 1978), it has increasingly intensified. Today, not only the Nande in Tetri but also those from Beni and Bu-

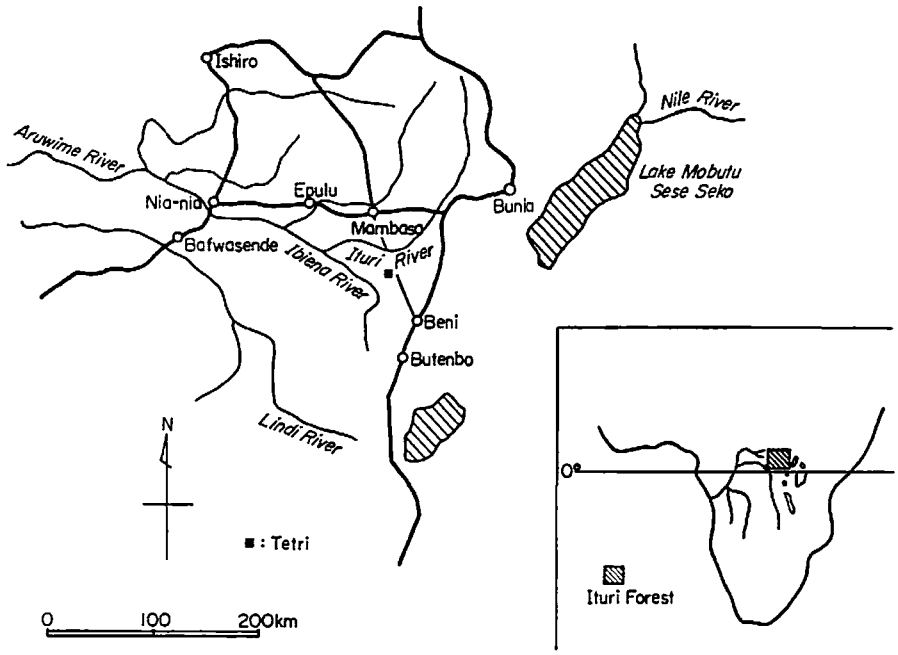

Fig. 1. The Ituri Forest.

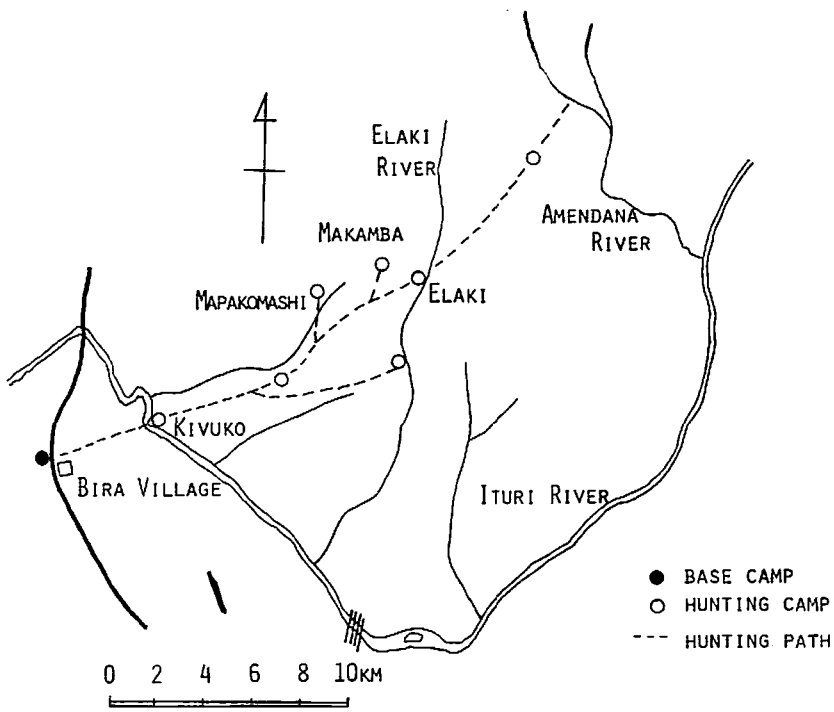

Fig. 2. Location of hunting camps of the Mawanbo band.

tembo towns visit the region to purchase meat. They carry cassava flour, rice and clothes on their back to the Mbuti's hunting camp as exchange for the meat. This intensive meat trading is now endangering the traditional symbiotic relationship between the Mbuti and the Bira. It has also been influencing the Mbuti hunting life by accelerating intensive hunting, individualization of the band members and changes in the band composition (Ichikawa, 1982). These recent changes will be discussed in another paper.

The data used in this study were mainly obtained during the hunting season in 1975. From January 9 to February 4, 1975 at the hunting camps of the Mawanbo band, and from February 13 to February 21 at Messere camp of the Apekele-II band, the following was investigated: 1) size and composition of hunting groups, 2) hours spent in the day's hunts, 3) number of hunting attempts on each day, and 4) minutes spend in each hunting attempt. These are concerned with the input in hunting. As for the yield from hunting; 1) species, number and weight of animals captured in each hunting attempt, 2) position of the net in which animals were captured, and 3) owners of the captured animals were recorded.

The Mawanbo band consists of 14 families, or 67 persons, of which 10 familes, or 45 persons participated in the hunting camps, while the rest stayed at the base camp near the Bira's village (Fig. 2). The Apekele-II band is composed of 25 families, or 94 persons, of which only 33 persons, mostly adults, participated in the hunting camp.

ACTIVITY PATTERN OF NET HUNTING

The method of net hunting has already been described in detail by Tanno (1976). Here, only its underlying principle is summarized. The net has a height of 1.0 to 1.5 m and a length of 30 to 100 m. Each net belongs to the person who wove it, usually a married male. When hunting is organized, about ten nets are connected to encircle an area of 0.03 to 0.05 km^2. From the open side, animals are roused from the bush and chased into the center so that they may get entangled in the nets (Fig. 3). Men operate the nets and kill the animals captured in the nets. Women are employed as beaters and to carry the captured animals.

The day's hunt consists of the following activities: 1) travelling from the camp to *kungya*, the first gathering place for the day's hunt where hunting fire is made, or travelling from the final netting place to the camp, designated here as T; 2) movement to the netting place, M; 3) setting the nets, N; 4) beating and killing the animals, H; 5) rewinding the nets, W; and 6) resting, or being engaged in activities other than hunting, such as gathering plant food or performing rituals, R. The activities from M to W comprise one hunting attempt, which takes 30 to 75 minutes, depending on the number and the length of the nets employed. The day's hunt is thus described as the regular repetition of the above-mentioned activities as follows:

T–M–N–H–W–M. . .W–T (Fig. 4).

During 23 days from January 9 to 31, 1975, a total of 170 hunting attempts were made by the Mawanbo band with a total of 422 persons participating in the hunts. Average number of hunting attempts per day and hours spent in the day's hunt were 7 to 8 times (7.7 ± 3.2, $N = 22$, excluding one day on which hunting was not organized), and 7 hours 20 minutes ($7{:}20 \pm 2{:}45$, $N = 22$), respectively. In the Apekele-II band, the average number of hunting attempts is less (5 times) than that in the Mawanbo band (Appendix 1-1 and 1-2). This is because the Mbuti in Apekele-II used longer nets (about 800 m consisting of 11 nets) than those in the Mawanbo band who used only 534 m or 10 nets in total. The longer the nets that

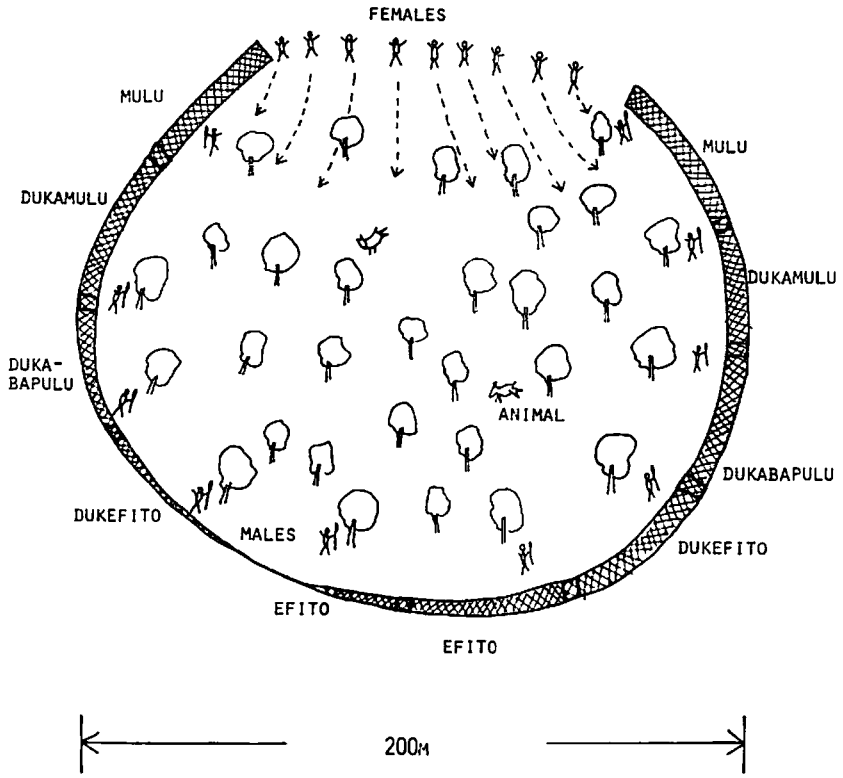

Fig. 3. Method of net hunting.

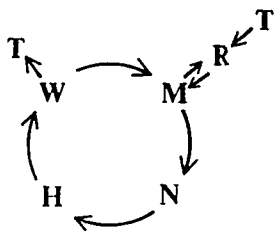

Fig. 4. Cycle of a hunting attempt.

are employed, the more time is required to perform one hunting attempt, and the fewer hunting attempts made in one day.

There is a strong correlation between the hours spent in hunting and number of hunting attempts made, as shown in Fig. 5 ($r = 0.93$, $p<0.001$, $N = 22$). This suggests the stability of net hunting activities. In the Mawanbo band, the average time spent in one hunting attempt is 45.9 minutes (45.9 ± 6.9, $N = 68$), which is fairly constant. Moreover, of the time required for one hunting attempt, only one fourth (10.3 ± 8.6 minutes, $N = 21$) was spent in movement to netting places (M). Netting places are usually chosen at distances of 5 to 20 minutes on foot, or 300 to 1,200 m. This means that the Mbuti do not put much effort into searching out the animals and that they set the nets rather unselectively in the forest.

The stability of the net hunting activity pattern, particularly the fairly fixed time spent

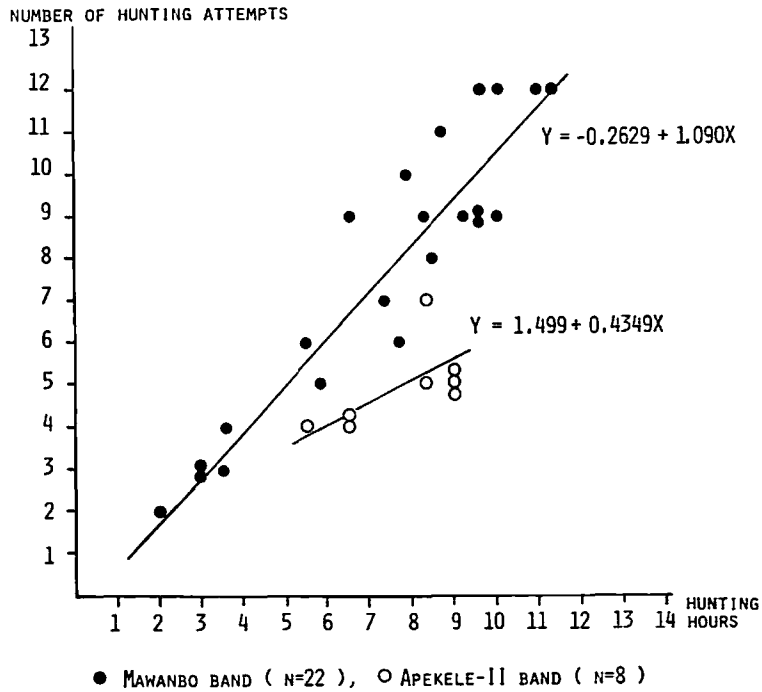

Fig. 5. Hunting hours and number of hunting attempts.

in one hunting attempts, accords well with the ecological conditions and fauna of the Ituri Forest. That is, in the dense bush it is difficult to locate the animals which are mainly nocturnal and stay immobile in the daytime. Moreover, the animals are distributed randomly in the forest as will be discussed later. Under such environmental conditions, beating and rousing the animals for a fixed time length in evenly or randomly selected places is more effective than searching them out in the bush. According to Harako (1976), the Mbuti archers also employ the beating method, which shows the effectiveness of this method throughout the Ituri Forest.

The strategy of the Mbuti's net hunting is quite different from that of bow-and-arrow hunting in the open land, or that of blowgun hunting in the forest. According to Lee (1979), the !Kung Bushmen in Botswana make much effort in searching for the animals to hunt. Kuchikura (1980) reported that the Semaq Beri of the Malay Peninsula spent as much as half the total time spent in the day's hunting (2:17 out of 4:32, on the average) in looking for arboreal monkeys, although it is relatively easy to locate a group of monkeys making a noise. In their strategies, searching for animals is almost as important as persuing them, and time and energy spent in travelling and moving are much more than those in net hunting.

THE CATCH AND EFFICIENCY OF THE HUNT

1. The Catch

Over 27 days from January 9 to February 4, a total of 142 animals, or 895.3 kg, were captured by the Mawanbo band. Of the animals captured, blue duikers (*Cephalophus monticola*)

Table 1. Animals captured by the Mawanbo band over 27 days.

Species	English	Number (%)	Weight in kg (%)
Cephalophus monticola	blue duiker	84 (59.2)	374.5 (41.8)
C. nigrifrons	black-fronted duiker	14 (9.9)	206.2 (23.0)
C. dorsalis	Bay duiker	9 (6.3)	150.0 (16.8)
C. leucogaster	Gabon duiker	2 (1.4)	34.4 (3.8)
Neotragus batesi	Bate's antelope	14 (9.9)	31.6 (3.5)
Haemoschus aquaticus	chevrotain	8 (5.6)	82.3 (9.2)
Bdeogale nigripes	black-legged mongoose	2 (1.4)	6.0 (1.5)
Genetta victoriae	Victoria genet	1 (0.7)	2.8 (0.7)
Crossarchus obscurus	dark mongoose	1 (0.7)	2.0 (0.2)
Atherurus sp.	brush-tailed porpupine	1 (0.7)	1.5 (0.2)
Rynchocyon cirnei	elephant shrew	1 (0.7)	0.5 (0.1)
Agelastes niger	black guineafowl	2 (1.4)	2.0 (0.2)
Francolinus lathami	forest francolin	3 (2.1)	1.5 (0.2)
Total		142 (100)	895.3 (100)

are the most important comprising 60% (84 head) in number, or 42% (374.5 kg) in weight of the total catch. Other important species are black-fronted duikers (*C. nigrifrons*), Bay duikers (*C. dorsalis*), water chevrotains (*Haemoschus aquaticus*), Gabon duikers (*C. leucogaster*) and Bate's antelopes (*Neotragus batesi*). Blue duikers and these five species together comprise 92% in number, or 98% in weight of the total catch (Table 1). Although the Mbuti consider as many as 50 species of mammals (Tanno, 1976: Ichikawa, 1982) edible, they actually focus on several small to medium-sized species in net hunting.

The average camp size during the investigation period was 45 persons with little daily fluctuation (Ichikawa, 1978). The yield per person per day is thus calculated at 0.74 kg including bones, teeth and other inedible parts. This amount is much more than that of the !Kung Bushmen (0.45 kg/person/day, calculated from the data in Lee, 1979), or that of the Central Bushmen (0.30 kg/person/day, according to Tanaka, 1980).

Now, let us examine whether or not it is possible from the viewpoint of calorific intake for the Mbuti to lead a hunting-dependent life consuming all the catch by themselves. In order to do this, it is necessary to consider the total consumption-days in more detail. For the present purposes, a young over 12 years old or an adult is counted as one person, a juvenile between 2 and 12 as one-half, and an infant under 2 is not counted. Total consumption-days during the investigation period is thus calculated at 926, with average camp size of 34.3 persons. In this case, 0.97 kg could be allocated to one adult consumptiop-day. As the ratio of edible part to the total weight of animals is estimated at 0.6, the amount of edible meat per consumption-day would be 0.58 kg, which contain about 1,200 Cal or even less (assuming 100 g edible meat contain 200 Cal on the average). It is by no means sufficient for an adult Mbuti engaged in exausting hunting almost every day.

However, during this period, there were two days on which hunting was not organized at all, and five more days on which only two to four hours were spent in hunting because of rain or shifting camp. If these seven days are excluded from the calculation, the total catch amounts to 859 kg and the average amount of edible meat per consumption-day is 0.76 kg, which contain nearly 1,500 Cal. There are usually several adults who remain at the camp without participating in the day's hunt. If they were engaged in gathering and contributed vegetable food to the diet, the Mbuti might be able to lead a hunting-dependent life.

Thus, a hunting-dependent life would be difficult in the Ituri Forest, and is not possible unless nearly all the adults and young work every day from morning until evening. Even if they could subsist by hunting, their life would be far from the image drawn by Sahlins (1972)

Table 2. Comparison of yield, efficiency and success rate.

Hunters	Area	Hungting method	Observation days	Yield (kg/person/days)	Efficiency (kg/person/hour)	Success rate	Source
Mbuti Pygmies	Ituri Forest						
	Apekele-II	net hunting	8	1.49	0.32	1.00	Ichikawa (Appendix, 1–2)
	Mawanbo, 1974	net hunting	13	1.06	0.39	1.00	Tanno, 1976
	Mawanbo, 1975	net hunting	27	0.74	0.28	0.92	Ichikawa (Appendix, 1–1)
	Mawanbo, 1980	net hunting	13	0.56	0.21	1.00	Ichikawa (Appendix, 1–3)
	Lolwa	net hunting	16	0.37	0.12	0.88	Harako, 1976 and 1981
	Lolwa	bow-and-arrow hunting		0.11–0.17	0.11	0.52	Harako, 1976 and 1981
	Andiri	bow-and-arrow hunting	12	0.54 or less	0.33	0.83	Terashima, 1983
BaMbote	Woodland, Eastern Zaire	net hunting	16	0.61	0.13	0.69	Terashima, 1980
Bushmen	Kalahari Desert						
	!Kung	snare hunting bow-and-arrow hunting	28	0.49	0.66 (5.3/person/day)	0.43	Lee, 1979
	G/wi & G//ana	bow-and-arrow hunting		0.30	0.22–0.32		Tanaka, 1980

that hunter-gatherers live in an original affluent society, or that by Lee (1968), that their life is full of leisure.

The actual life of the Mbuti is not so hard as the speculated hunting-dependent life, because they exchange meat for cassava and other farm foods. The unit of exchange is one gutted blue duiker without a head, or one hind or front leg of a medium-sized duiker, both weighing from 2 to 3.5 kg including meat and embedded bones. Heads and guts of the duikers, and other small animals like Bate's antelopes, porcupines, genets and Guinea-fowls, which together comprise about 50% of the total weight, are consumed at the camp. In 1975, one unit of meat was exchanged for 15 kg of cassava. In this case 2,500 to 4,000 Cal of meat were exchanged for 12,000 Cal of cassava. From the point of view of energy, the Mbuti could obtain from cassava three to four times as many calories as from meat. If they exchange all the duikers and chevrotains for cassava and consume only heads, guts and other small animals, they may obtain 600 Cal from meat and 1,800 to 2,400 Cal from cassava, which is well over the amount needed to sustain their subsistence. In the instance that they exchange two thirds of the catch for cassava and one third for clothes, they may obtain 600 Cal from meat and 1,200 to 1,600 Cal from cassava, which may also suffice their daily calorific requirements.

2. Efficiency of the Hunt

From January 9 to February 4, a total of 422 person-days participated in the hunts and the return was 895.3 kg in total. The average yield per person per hunting-day is 2.1 kg. The average yield per person per hunting hour is calculated at 0.28 kg (Appendix 1-1). The efficiency of net hunting in other cases are 0.12 kg/person/hour (calculated from the data in Harako, 1976) in the Lolwa band, 0.39/person/hour at the Mawanbo-Kalonge (Katala) joint camp in 1974 (Tanno, 1976: for the calculation of efficiency, see Terashima, 1983), and 0.21 kg/person/hour at the Mawanbo camp in 1980 (Appendix 1-3). The efficiency of net hunting is within the range of 0.12 to 0.39 kg/person/hour. It should be noted here that the efficiency of the Apekele-II band, 0.32 kg/person/hour (Appendix 1-2), also falls within this range. There is not clear difference in the efficiency of the Apekele-II band and the Mawanbo band, although the former's nets are nearly 1.5 times as long as the latter's. This is because the longer the nets, the more time and manpower are required for each hunting attempt, although the average catch per attempt may increase.

In Table 2, meat yield per person per day (a juvenile or an infant is counted as one person in this case) and hunting efficiency (yield per person per hunting hour) are listed for several hunter groups who do not use any firearms. It is understood that the efficiency of net hunting is not better than that of other hunting methods, although the yield per person per day is much greater among the Mbuti than other hunters. It is thus realized that the Mbuti obtained a larger amount of meat by investing a larger amount of labor including female's labor as beaters. This accords with the notion made by Abruzzi (1979) and Terashima (1983), that net hunting is the best method of maximizing the total catch. It is partly because they are involved in meat trading that they invest so much labor in hunting. The traders try to make the Mbuti intensify the hunting and maximize the total catch by investing as much labor as possible, although this is not always successful.

FLUCTUATION OF THE CATCH

1. Stability of the Catch

It is not the efficiency of hunting but the stability of the catch that characterizes the Mbuti's

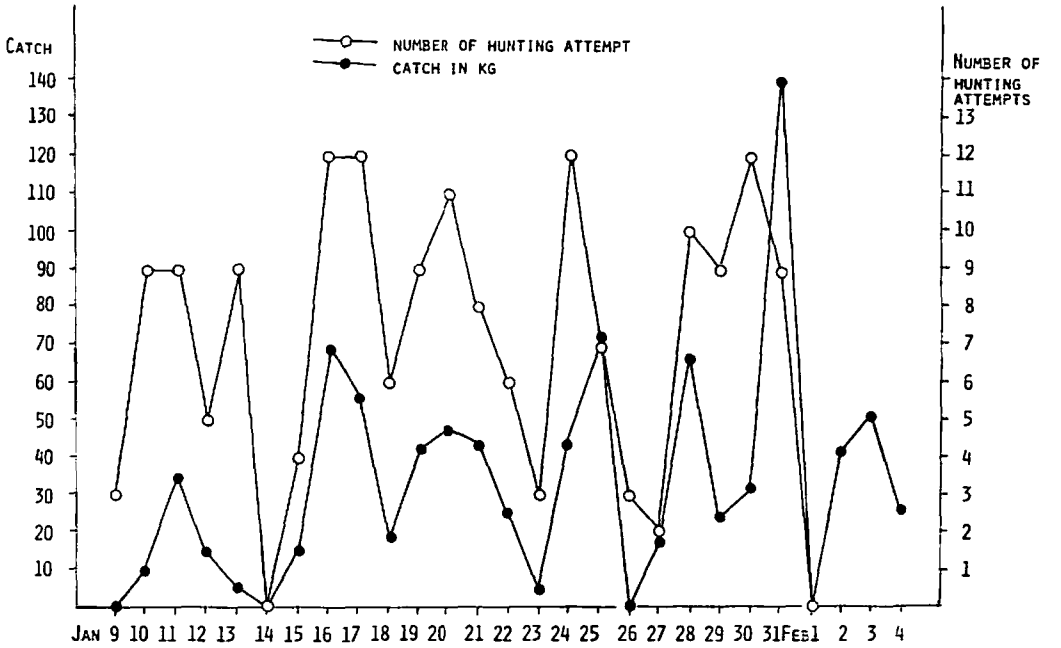

Fig. 6. Daily fluctuations of the number of hunting attempts and the catch in the Mawanbo band.

net hunting. Fig. 6 shows daily fluctuations of the catch of the Mawanbo band. Over 27 days, there were only four days on which nothing was captured. On two of these four days net hunting was not organized at all. On the other two days only 2 to 4 hours were spent in hunting because of rain or moving a camp. The success rate, which is defined as the ratio of the days on which at least one animal is captured to the total days of hunting, is 0.88 to 1.00 for net hunting. This is much higher than that of bow-and-arrow hunting in open land (Table 2).

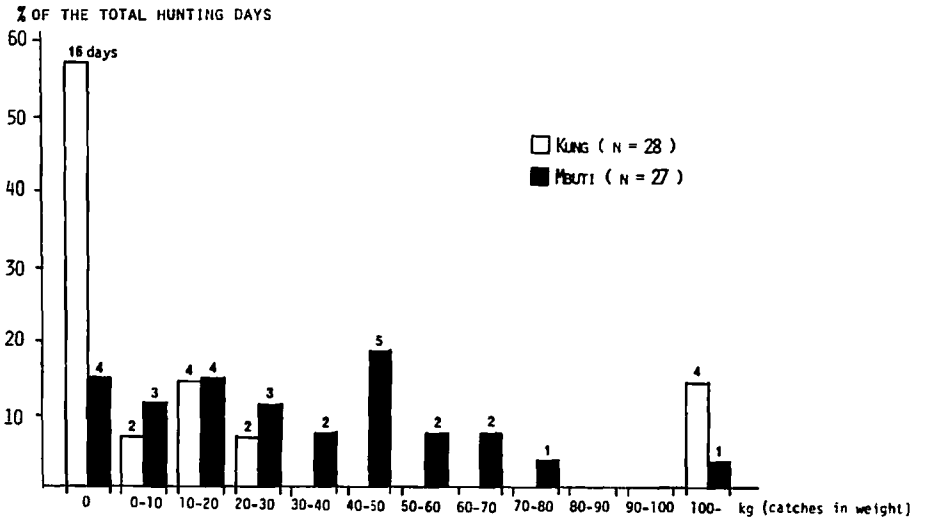

Fig. 7. Comparison of daily catches of the Mbuti with that of the !Kung.

The daily yields of the Mbuti are compared with those of the !Kung Bushmen. As Lee (1979) stated that the ratio of edible parts to the total weight was 0.5, and that the average group size of the !Kung was about 30 persons, two thirds that of the Mbuti, daily yields in live weight of the !Kung were obtained by multiplying the figures in Lee (1979, p. 266) by three. It is clear that the daily meat supplies fluctuate much more among the !Kung than among the Mbuti (Fig. 7). Among the !Kung, on 16 out of 28 days (57%) nothing was killed. The success rate for the entire group is only 0.43. When something is killed, usually a large amount of meat is obtained, although this does not occur frequently. Their hunting is quite unstable and unreliable as a means of procuring daily food, compared with the net hunting of the Mbuti.

2. Size of the Animals

The ecological and technological factors causing the stability of net hunting should be analysed. The size of the animals is one of the major factors contributing to stability of hunting. If the total catch in weight remains constant, the smaller the animals, the larger the number. Therefore, the smaller the animals are, the more stable the hunting is likely to be.

The main targets of the net hunting are blue duikers weighing about 4 to 6 kg (4.54 ± 0.83, $N = 135$), and other forest duikers weighing from 10 to 25 kg. Animals that can be caught with nets are less than 30 kg in weight, about the size of a young bushpig. Animals exceeding this will tear the nets which are made of twisted inner bark of a creeping plant, *Maniophyton fulvum*. During the observation period, 142 animals yielded 895.3 kg. The average size of the animals captured was 6.3 kg.

Compared with the Mbuti, the !Kung usually hunt larger animals including giraffes, elands, kudus, gemsboks and other large-sized herbivores with bows and poisoned arrows. The biggest animals killed during the 28 observation-days were warthogs weighing more than 70 kg per head. As 18 animals comprised the total catch of 411.8 kg, the average size of the animals is calculated at 22.9 kg, about four times as large as that in net hunting. This means that if the Mbuti obtain the same amount of meat as the !Kung, they kill four times as many animals as the !Kung. The size of the animals is thus an important factor affecting the stability of hunting.

3. The Effort and Return

The stability of the ratio of the return to the hunting effort is a crucial factor in the stability of the catch. It is suggested in Fig. 6 that the number of hunting attempts covaries with the amount of catch. In other words, the hunting effort correlates with the return. For 17 days on which hunting was attempted under a similar environmental condition, the day's catch in weight significantly correlated with the hunting effort in terms of person-hours spent in the day's hunt ($r = 0.56$, $p < 0.05$, $N = 17$, Fig. 8). Thus, in net hunting, the more manpower invested in hunting, the more catch they are likely to obtain. If they invest the same amount of manpower in hunting, they are likely to get a similar amount of animals.

The opposite is the case in the !Kung's hunting. They often spend many hours in hunting without getting any catch, although they may happen to kill a big game weighing over 100 kg within several hours from starting from the camp. The returns from the hunting efforts are less predictable, unlike the case in the Mbuti's net hunting.

4. Distribution Pattern of the Animals

It is difficult to estimate the population density of animals in the dense forest, but the following calculation was made for the animals captured by net hunting. Animals encircled by the nets and the beaters are not driven from the outside of the circle (Fig. 3). Also, netting

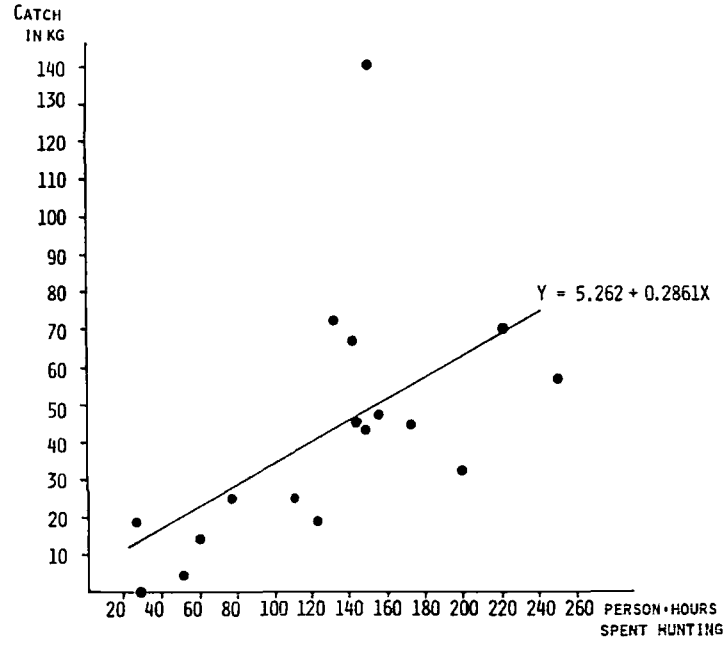

Fig. 8. Input (person-hours spent in hunting) and output (catch in kilograms) of the Mawanbo band from 15th to 31st, January, 1975.

places are selected almost randomly, or evenly in the forest. Given these conditions, the population density and biomass of animals can be claculated from the average number and weight of animals captured in one hunting attempt.

During 23 days from January 9 to 31, 1975, a total of 170 attempts were made at three hunting camps of the Mawanbo band. The total catch was 123 animals, or 777.7 kg. The average per attempt is 0.72 animals, or 4.6 kg. In this period a total of 10 nets was used with a full length of 534 m, which together with the beaters enclosed an area of 0.03 km^2. Estimating from the author's own observations and the data from Harako (1976), only 30 to 40% of the animals in the net enclosure are finally captured. Taking these factors into consideration, the population density is estimated at 50 to 80 head/km^2, and biomass at 300 to 500 kg/km^2, excluding larger mammals such as bushpigs, buffaloes, okapis, elephants, and arboreal monkeys which cannot be captured by net hunting.

Next, the distribution pattern of the animals is examined. There are usually more animals in the interior of the forest than in the area close to the agriculturalists' settlements where intensive hunting is done both by the agriculturalists and by the Mbuti. Certain species like water chevrotains are distributed only in the area along the rivers and the major streams. However, the overall distribution pattern of animals in the forest is not clumped, nor patchy to the Mbuti net hunters, as is discussed below.

During 17 days from January 15 to 31, 1975, a total of 135 attempts were made in a similar environment and the total catch was 110 animals. The number of animals captured in one attempt varied from 0 to 6. In Table 3, the observed frequencies of hunting attempts in which 0 to 6 animals were captured are shown compared with the frequencies expected from a poisson distribution. The expected frequencies (F) are obtained from the following formula:

$$F = N \cdot e^{-m} \cdot \frac{m^x}{x!}$$

Table 3. Number of hunting attempt in which 0 to 6 animals were captured. F shows frequencies expected from a poisson distribution.

	0	1	2	3	4	5	6 animals
f	60	50	19	4	1	0	1
				6			
F	60.1	48.6	19.7	5.3	1.1	0.2	0.0
				6.6			

$\chi^2=0.1199$; d.f.=2; $0.95>p>0.90$

where N indicates the total number of hunting attempts (135), m the average number of animals captured in one attempts (0.81, $s^2 = 0.92$), x the number of animals captured in one attempt, and e the natural logarithmic base. In Table 3, it is clearly shown that the observed frequencies fit very well with the expected frequencies of a poisson distribution, a random distribution ($\chi^2 = 0.1199$, $d.f. = 2$, $0.95>p>0.90$). The ratio of the variance to the mean is 1.136, which is not significantly larger than 1 by F-test ($p<0.05$). This also suggests a random distribution.

Netting places are chosen almost evenly in the forest as stated before. Therefore, the random distribution of the catch per attempt verifies that the overall distribution pattern of the animals in the forest is also random. This explains well why the catch significantly correlates with the number of hunting attemps.

The random distribution of the animals in the Ituri Forest is in sharp contrast with a patchy or clumped distribution of animals and other resources in the open land. In the open land, a hunter spend a long time in travelling and searching for animals, often in vain, but when he encounters them, they are usually large and gregarious.

INDIVIDUAL DIFFERENCE IN THE CATCH

It has been pointed out that the Mbuti obtained meat much more regularly than the !Kung and that there exists a significant correlation between the catch and the manpower invested in hunting. However, these are only applicable to the catch and manpower of the entire hunting group. For the individual hunters, or families, the situation is quite different. There is a considerable difference in the catches of the individual hunters, since the animals belong in principle to the owners of the nets in which they are caught.

There are two factors which systematically cause individual differences in the catch. The first is the position of the nets. Generally speaking, more animals may be caught in nets set at the inner position, that is, opposite to the beaters (Fig. 3). Table 4 shows the catch in each position. *Efito* and *dukefito* are the best positions in which to capture animals. However, the position of the net each hunter takes hunting is not fixed. They change the positions for

Table 4. The catch in each position of net.

Position of net	Catch	
	Number	Weight (kg)
efito	35	233.8
dukefito	33	180.8
dukabapulu	14	105.4
dukamulu	24	176.8
mulu	25	146.3
Total	142	895.3

Table 5. Individual catches during 27 days from January 9 to February 4, 1975.

Length of net (m)	Catches		Success rate
	Number	Weight (kg)	
84	19	142.7	0.56
66	20	125.5	0.56
59	18	125.4	0.44
57	24	131.2	0.56
57	20	126.8	0.44
53	7	30.5	0.20
48	9	53.3	0.32
44	12	88.3	0.36
34	6	24.1	0.24
32	7	47.5	0.24
Total 534	142	895.3	

every three hunting attempts. That is, after three casts of nets, the one with his net in *mulu* moves to *efito*, the one in *efito* to *dukefito*, the one in *dukefito* to *dukabapulu*, and so on. This is one of the economic aspects of egalitarianism, the underlying principle of the Mbuti society. The individual Mbutis thus have equal opportunities to make a catch, other things being equal.

The second factor is the length of the nets. It is quite natural to suppose that the longer the net a hunter owns, the more animals he will capture. A comparison of the length of the nets and individual catches is made in Table 5. There is a significant correlation ($r = 0.83$, $p<0.01$) between the length of the nets and the amount of catches. However, this is only a general tendency. Certain individuals differ considerably in the catch, which is not completely attributable to the difference in the length of nets. For example, a hunter with a net of 57 m captured more than 130 kg, while one with a 53 m net captured only 30.5 kg (Table 5).

Besides the difference in the total catch, there are considerable daily fluctuations in individual catches. Fig. 9 shows the accumulative catches of individual hunters (net owners) of the Mawanbo band from January 9 to February 4, 1975. Some hunters had no catches for more than ten days. The success rates of the individuals are by no means high, ranging from 0.20 to 0.56 (Table 5). As far as individual hunters are concerned net hunting is neither a stable nor reliable method of procuring meat.

Net hunting does not require much skill and even a young boy of 12 to 13 years can participate as a full-fledged hunter. If there is not much difference in the length of the nets, individual catches will be averaged out in the long run. However, considerable differences may arise within a relatively short period, as in the case of the Mawanbo band.

How do the Mbuti deal with the problem of instability and unreliability of the individual catches? Since the total catch of the entire band is stable and reliable, one solution is to pool all the day's catch and redistribute it to the entire band, disregarding individual ownership of the animals captured. Another solution is to distribute the catches between individuals, leaving the individual ownership as it is. For the reason discussed later, the former is not likely to occur in an egalitarian society like that of the Mbuti. They take the latter solution. It is well known that the Mbuti quite frequently distribute the meat or other foods to one another.

The sharing or distribution among the Mbuti has already been described in detail (Harako, 1976; Ichikawa, 1982). It consists of two stages. The first distribution is made according to the role each hunter takes in the day's hunt. For example, the one who starts earliest in the morning to make a hunting fire, *kungya*, takes all the head of blue duikers and a lower part

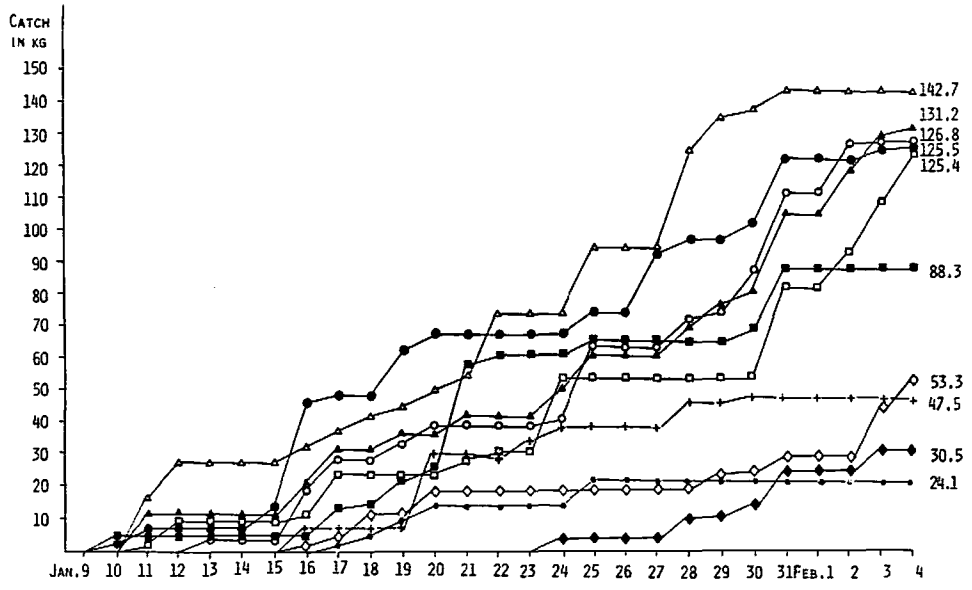

Fig. 9. Accumulative catches of individual hunters of the Mawanbo band.

of the limb of medium-sized duikers caught that day. The one who helps the owner kill the animals in the nets takes a part of the breast, called *esosi*; the one who hunts with an other's net, one front or hind leg of each medium-sized duiker, and one for every two to four blue duikers caught with that net, and so on (Fig. 10). The first distribution is thus clearly defined and accepted by all the band members.

The second distribution is made in an informal way. Those who have failed in the day's hunt and have no right to claim the first distribution are given a portion of meat or farm food obtained in exchange for the meat that someone else has got. Whether or not the second distribution is made is said to be at the owner's will and no one can force another to do so.

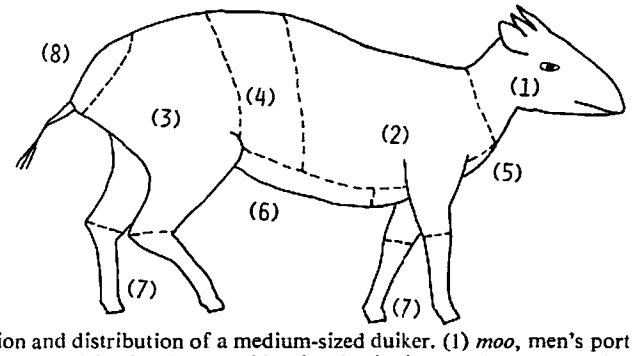

Fig. 10. Dissection and distribution of a medium-sized duiker. (1) *moo*, men's portion eaten communally at the men's place. (2) *mbombo*, one side of which is given to the woman who carries the animal to the camp. (3) *kipe*, one of which is given to the man who use the other's net. (4) *seka*, given to the man who made the hunting fire. (5) *esosi*, given to the one who helped the owner kill the animal. (6) *ekba*, given to the one who calls people from the camp to the hunting party. (7) *kaka*, taken by the owner of the net. (8) *tinakondo*, taken by the owner.

But generally, the meat is distributed to others and all the band members get at least a portion of meat, unless the amount of meat is too small to distribute to the entire band. A full description of actual examples of distribution were given in Ichikawa, 1982.

DISCUSSION

This study has examined the question whether or not the Mbuti could subsist by hunting, had they not been in a symbiotic relationship with agriculturalists. The conclusion is that such a hunting-dependent life would not be impossible in the Ituri Forest from the calorific viewpoint, although it would be quite a hard life. Without the nets which were introduced by the agriculturalists (Harako, 1976) and improved the reliability of hunting, the hunting life would have been even harder.

According to recent studies (Foley, 1982: Hill, 1982), hunting would be more important than gathering in an environment with abundant herbivore fauna, for example in a savanna area. The population density and biomass of small to medium terrestrial mammals (most of them are duikers) which are the target of net hunting are estimated at 50–80 head/km^2 and 300–500 kg/km^2, respectively in the Ituri Forest. In savanna areas the biomass of herbivores range from several thousand to twenty thousand kilograms per square kilometer (Coe et al., 1966), which is much more than that in the Ituri Forest. However, a large proportion of herbivore biomass in savanna areas consists of large herbivores, such as elephants, buffaloes, zebras and large antelopes exceeding 100 kg in weight. The density and biomass of small to medium-sized herbivores less than 100 kg are 5 to 30 head/km^2 and 150 to 800 kg/km^2 (Delany and Happold, 1979), which are not much more than the figures for the Ituri Forest. Moreover, if the density (number of animals) and not biomass (weight) is considered, there are rather fewer animals in savanna than in the Ituri Forest, even if larger herbivores are included. These points are of great importance. Small and medium-sized animals are easily captured by less skilled and less well equipped hunters like those in the paleolithic era. Also, the greater the number of animals, the higher the encounter rate with animals may be. The high density of small to medium-sized animals thus reduce the cost of hunting, particularly the cost of searching. Therefore, in order to evaluate the importance of hunting in savanna areas, it is necessary to consider other factors, such as the density of animals and their sizes, in addition to the overall biomass in a given area.

It has been concluded that the catch of the Mbuti's net hunting is considerably stabler than that of the !Kung Bushmen which fluctuates greatly from day to day. Even if the Bushmen obtain as much meat as the Mbuti, they can by no means lead a hunting-dependent life as the Mbuti could do though with considerable difficulty. This is because humans require frequent and regular eating, which the unstable Bushman-type hunting does not provide.

There exists a marked difference in the feeding rhythm between herbivores and carnivores. Herbivores generally feed more frequently and spend more time in feeding. Carnivores, on the contrary, feed less frequently and eat a large amount at one time. The intervals between feedings are much longer in carnivores, especially in large carnivores. For example, although lions need 5 to 7 kg of meat per day on the average, they often eat as much as 20 to 30 kg or even more at once time. They can consume meat sufficient for five days at one time and remain without food for more than a week. Their feeding frequency is estimated at once every two to four days on the average (Schaller, 1972).

The difference in the feeding rhythm is due to the difference in the nature of food taken.

Although herbivore's food, the grasses, are abundant and obtained with little effort, they contain small amount of calories per unit weight; that is, calories are dispersed in the grasses. On the contrary, prey animals are just like big package of calories containing several thousand to several hundred thousand calories in one package. They are encountered less frequently and are only obtainable at a large cost. It is the best way for an animal feeding on such big package of calories to consume a prey as soon as possible in order to avoid other predators also after the prey. Therefore, even if the amount of calories ingested remains the same, the carnivore's feeding rhythm is different from that of a herbivore.

Primates generally have a feeding rhythm like that of herbivores. Although humans are omnivorous and eat less frequently than other primates, they also belong to the frequent eaters. This is clearly expressed in the frequency of meals, or other foods taken between meals. Therefore, if a human group is to lead a hunting-dependent life as most carnivores do, it must be supplied with meat frequently, at least once for every day or every other day. In this regard, unstable hunting like that of the Bushmen is not sufficient to sustain the group.

The ecological and technological conditions of the stability of the net hunting have been analysed. It has been pointed out that abundant small to medium-sized antelopes, their random distribution in the forest, and correlation of effort and return are the major factors contributing to the stability of the catch. The net hunting consists of a regular repetition of activities. Netting places are chosen almost evenly in the forest, and time spent in one place (one hunting attempt) does not vary much. These strategies are well suited for the ecological conditions of the Ituri Forest.

Iwasa et al. (1981) theoretically examined the relationship between the prey distribution pattern and the optimal foraging strategy. According to them, in an environment where the prey is distributed randomly, the optimal strategy is to fix the time spent in one place (patch), while in an environment with a clumped prey distribution, the optimal strategy is to fix the giving up time, that is, to fix the time from capturing the last prey to moving out the place. This theory accords well with the examples of the Mbuti hunting. In the Ituri Forest where animals are distributed almost randomly and it is difficult to locate animals in the dense bush, the Mbuti seem to fix the time spent in each netting place.

Although the total catch of the entire band is stable, the individual catches vary considerably from person to person, and form day to day. There may be three ways to adjust the individual differences and fluctuations in the daily catch. The first is to eat as much as they can while food is available and stay hungry for days without a catch. This is to adjust the human eating rhythm to that of carnivores, but it is difficult to alter the feeding rhythm beyond a certain point. The second is to store the excess food for the days without food. Although the Mbuti do know how to dry and preserve meat, they seldom preserve it, unless it is exchanged with the agriculturalists or meat traders, or when they happen to kill such big game as an elephant. The preservation of meat and other foods prevails in the middle to higher latitudes where seasonal variations in food supply are conspicuous. Hunter-gatherers in the middle to higher latitudes usually harvest various foods in autumn and preserve them for use during the hard winter period. In the tropical rain forest like the Ituri Forest, there is not such a conspicuous seasonal variation in the food supply. Moreover, meat or other foods quickly become rotten in a humid and warm environment, unless they are always kept dry. Therefore, the Mbuti have not developed the habit of food storage.

The third possibility is to distribute to one another the meat or other foods obtained in exchange for the meat. This is what the Mbuti have adopted. Through distributing to one another, the Mbuti level out the variation in the individual catches and get a stable food supply. This is an interdependent system, a kind of social insurance, to adjust the instability

of the individual catches, as Draper (1978) and Cashdan (1980) have pointed out in the study of the Bushmen social life. The Mbuti may not be conscious of this function of distribution. They usually share the meat and other foods with others based on the principle of generalized reciprocity (Sahlins, 1972), another important underlying principle of the Mbuti society.

There is another way to even out the individual variation on the catch; that is to collect all the day's catch in one place and redistribute it to the entire band. However this is not done by the Mbuti who clearly define the individual ownership of the animals captured in the nets. In order to collect the animals owned by individuals, a central authority or strong leadership may be necessary. The Mbuti society is an egalitarian one (Ichikawa, 1978) in which any one individual has no right to exert power over other band members. Anyone that intends to take the leadership, seek for prestige, or merely assume the responsibility will be the target of criticism, as Turnbull (1961) clearly demonstrated. Moreover, the individual catches will naturally be levelled out in the long run, since each one has almost equal opportunities of making a catch by changing the position of the nets every three hunting attempts. Under such conditions, sharing with one another based on the principle of general reciprocity is the best way, since it does not involve any authority or other institutional devices which are responsible for the collection and redistribution of the catch.

Recently, as the meat trading has become intensive, the importance of sharing as a means of evening the meat supply has been declining. Some Mbutis now obtain food on credit from the meat traders staying in the hunting camp, instead of depending on one another through sharing among themselves. When they fail in the day's hunt, they borrow farm foods from the traders, instead of receiving food distributed by other band members. Meat trading has thus accelerated the individualization of the band members. Such a tendency has not yet become conspicuous in the Tetri region, although in the area along the Beni-Bunia road where meat trading is especially intensive, serious changes have been taking place. Among many Mbutis in this area, the original patrilocal bands have disintegrated and they have formed composite bands consisting of the members from various bands. These recent changes will be discussed in another paper.

ACKNOWLEDGEMENTS The field research on which this study is based took place from August, 1974 to July 1975, and October, 1980 to January, 1981, suppported by the Grant-in-Aid for Overseas Scientific Research (Nos. 7436, 7532 and 504132) from the Ministry of Education, Science and Culture, Japan.

I wish to express my hearty thanks to all those who supported me in carrying out this study; to the Délégué Général of the Institute de Recherche Scientifique (I.R.S.), République du Zaïre, for accepting me as Research Associate; to Prof. Takayoshi Kano of the University of the Ryukus, Prof. Junichiro Itani of Kyoto University, the directors of the expeditions; to all my colleagues at Laboratory of Human Evolution Studies, Faculty of Science, Kyoto University, for their valuable suggestions and comments.

I also wish to thank my friends, the Mbuti and the Bira of the Ituri Forest from the bottom of my heart, for their kind help in this research.

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Appendix 1-1. Hunting records in the Mawanbo band from January 9 to February 4, 1975.

Date	Camp	Hunting group		Hunting hours	No. of hunting attempt	Man-hour	Catches		Remarks
		Male	Female				Number	Weight (kg)	
Jan. 9	Kivuko	10	5	3:00	3	45.0	0	0	Camp moved.
10		12	5	9:30	9	161.5	2	9.0	
11		11	8	9:10	9	174.2	6	34.2	
12		10	6	5:50	5	92.8	3	14.0	
13		12	6	10:00	9	180.0	2	4.7	
14		-	-	-	-	-	-	-	Rest and fishing.
15	Elaki	12	5	3:35	4	59.5	2	14.0	Camp moved.
16		13	10	9:40	12	222.4	9	68.8	
17		12	11	10:55	12	250.7	13	56.4	
18		10	6	7:40	6	122.7	3	18.3	
19		12	6	8:15	9	148.5	7	42.1	
20		11	7	8:40	11	156.1	8	47.3	
21		10	7	8:30	8	144.5	5	44.0	
22		9	5	5:30	6	77.0	3	24.9	
23		8	5	3:30	3	45.5	1	4.2	Rainy day.
24		11	6	11:15	12	172.9	7	43.6	
25		11	7	7:20	7	131.9	12	71.6	
26		5	4	3:00	3	27.0	0	0	Rainy day.
27	Makamba	9	4	2:00	2	26.0	1	18.3	Camp moved.
28		10	8	7:55	10	142.2	11	66.5	
29		9	8	6:30	9	110.5	5	24.7	
30		12	8	10:00	12	200.0	7	31.3	
31		10	9	9:30	9	152.0	16	139.8	
Feb. 1		-	-	-	-	-	-	-	Rest
2		8	7	?	?	?	6	41.2	
3		10	6	?	?	?	8	50.7	
4		11	7	?	?	?	5	25.7	
Total		258	167	160:20*	170*	2842.9*	142	895.3	

*: Total for the 23 days from 9th to 31st, January, 1975.

Appendix 1-2. Hunting records in the Apekele-II band from 14th to 21st, February, 1975.

Date	Camp	Hunting group		Hunting hours	No. of hunting attempt	Man-hour	Catches		Remarks
		Male	Female				Number	Weight (kg)	
Feb. 14	Mesaere	15	4	6:30	4	123.5	2	13.5	
15		14	6	8:20	7	166.6	10	87.6	
16		14	7	9:00	5	189.0	6	51.8	
17		14	5	9:00	5	171.0	9	82.5	
18		15	6	8:20	5	174.9	8	47.4	
19		14	5	9:00	5	171.0	5	50.4	
20		12	4	5:30	4	88.0	2	9.9	
21		14	3	6:30	4	110.5	3	25.8	
Total		112	40	62:10	39	1194.5	45	368.9	

Appendix 1-3. Hunting records in the Mawanbo band from 5th to 17th, Decembr, 1980.

Date	Camp	Hunting Group		Hunting hours	No. of hunting attempt	Man-hour	Catches		Remarks
		Male	Female				Number	Weight(kg)	
Dec. 5	Mapa-kamashi	8	9	8:00		136.0	8	31.6	
6		7	6	9:00		117.0	3	13.6	
7		7	5	10:10		122.0	12	53.0	
8		8	5	6:45		87.8	4	21.2	
9		9	8	9:45		165.8	8	70.8	
10		-	-	-		-	-	-	
11		11	7	9:15		166.5	1	6.0	
12		9	7	6:15		100.0	1	16.0	
13		9	6	3:20		50.0	1	4.8	
14		-	-	-		-	-	-	
15	Panjia-panda	9	6	4:30		67.5	3	14.5	
16		11	7	8:35		154.8	7	35.5	
17		10	8	9:30		171.0	5	11.9	
Total		88	74	85:05		1338.4	53	278.9	

Appendix 2. Individual catches from January 9 to February 4, 1975.

Date / Individuals	Jan. 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Feb. 1	2	3	4	Total
A	-	-	1	2	-	+	-	1	1	1	1	1	1	1	-	-	2	-	-	3	2	1	1	+	-	-	-	19
84m			16.7	10.5				5.0	5.6	4.2	3.0	5.4	5.0	18.5			20.1			33.1	9.1	2.0	4.5					142.7
B	-	1	2	-	1	+	1	2	1	-	2	1	-	-	-	-	2	-	1	1	-	1	2	+	-	2	-	20
66m		4.0	2.5		0.5		4.0	35.0	2.3		13.7	5.2					8.3		18.3	2.6		3.8	21.5			3.8		125.5
C	-	-	1	1	-	+	-	1	2	-	-	-	1	1	-	2	-	-	-	-	-	-	2	+	3	2	2	18
59m			4.5	3.5				3.6	13.9				3.0	2.2		23.6							27.8		11.2	17.5	14.6	125.4
D	-	-	2	-	-	+	-	2	3	-	1	-	1	-	-	2	3	-	-	2	1	1	2	+	1	2	1	24
57m			10.5					9.7	10.0		5.5		5.7			8.8	11.3			8.6	6.0	4.0	24.3		15.3	9.0	2.1	131.2
E	-	-	-	-	1	+	-	2	2	-	1	1	-	-	-	1	2	-	-	2	1	1	4	+	2	-	-	20
57m					4.2			14.5	9.4		5.0	4.6				2.5	24.4			6.9	4.6	12.0	24.0		14.7			126.8
F	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	1	2	+	1	-	-	7
53m																4.2				7.3		4.0	10.5		4.5			30.5
G	-	-	-	-	-	+	-	1	1	1	-	1	-	-	-	-	-	-	-	-	1	-	1	+	-	1	2	9
48m								1.0	3.0	9.7		5.5									5.0		4.2			15.9	9.0	53.3
H	-	1	-	-	-	+	-	-	2	-	1	1	2	1	-	-	2	-	-	-	-	1	1	+	-	-	-	12
44m		5.0							9.2		10.5	2.0	30.3	4.2			4.1					4.5	18.5					88.3
I	-	-	-	-	-	+	-	-	1	1	1	1	-	-	-	-	1	-	-	-	-	-	1	+	-	-	-	6
34m									3.0	4.4	4.4	4.8					3.0						4.5					24.1
J	-	-	-	-	-	+	-	1	-	-	-	2	-	-	1	1	-	-	-	1	-	1	-	+	-	-	-	7
32m								10.0				19.8			4.2	4.5				8.0		1.0						47.5
Total (number)	0	2	6	3	2	+	2	9	13	3	7	8	5	3	1	7	12	0	1	11	5	7	16	+	6	8	5	142
(weight)	0	9.0	34.2	14.0	4.7		14.0	68.8	56.4	18.3	42.1	47.3	44.0	24.9	4.2	43.6	71.6	0	18.3	66.5	24.7	30.3	139.8		41.2	50.7	25.7	895.3

Figures show the number (above) and weight in kg (below) of the animals captured. +: Hunting was not carried out.